Transverse-flow plates or frames **2** and **3** include hollow sections **40, 40'** for passage of the combustion gases and reforming gases, respectively.

[0032] In the stack of these bicatalyst flow plate units or cells **U**, the combustion transverse-flow plate **2** contacts a combustion-catalyst-coated face **C** of an adjoining unit's separator plate **1-A**, while the reforming transverse-flow plate **3** is arranged so as to contact a reforming-catalyst-coated face **R** of an adjoining unit's separator plate **1-B**. Thus, the reformer stack contains a plurality of alternating channel or slot-type combustion reaction zones **A** and reforming zones **B** separated by thin bi-catalyst-coated separator plates **1, 1-A, 1-B, 1-C ..... 1-N.** Dashed arrow **42** shows the flow of the reforming gas from the reforming gas inlet via **44** to the reformer outlet via **46**, at which point the gas is hydrogen-rich as a result of the reaction at the catalyst coated surface **R** on face **1b** of plate **1**. Similarly, the dashed arrow **48** shows the flow of the combustion gas from the combustion gas inlet via **50** combustion exhaust gases outlet **52**. The alternating orientation of the bi-catalyst plates can be characterized as the following arrangement, where R represents the reforming reaction catalyst, and C the combustion catalyst, the slash represents the separator plate, and the space represents the channel or reaction zone: R/C C/R R/C C/R ....R/C. It should be understood that the reforming and the combustion catalysts can be closely similar, if not identical, so that the designation R and C refer to their functionality in the specific chemical environment present in the two opposite sides of each plate.

B. <u>Catalytic separator plate reactor assembly.</u>

[0033] The bicatalytic separator plate reactors shown in **Fig 1** can be assembled by joining the bicatalytic separator plates and transverse-flow plates together, e.g., by clamping or bolting (using appropriate through-bolts, not shown), or preferably by brazing or diffusion bonding under pressure. Alternatively, the reactor can be

assembled by means of gaskets arranged between the bi-coated plates and the transverse-flow plates. The brazed structure is lightweight and compact, but not disassembled easily for cleaning, inspection or catalyst replacement. Use of gaskets for sealing results in a bulkier and heavier structure that, however, can be easily opened to access the catalyst for maintenance, cleaning or replacement.

[0034] **1. Brazing.** The metal surfaces to be brazed must be clean for the metal parts to adhere. Since the process for depositing the catalytic coatings on the plates results in the oxidation of the surface of the plates, brazing methods can not be used without first cleaning the surfaces to be joined. Aggressive mechanical or chemical treatments are needed to eliminate the oxide layer. Those treatments can damage the thin metal separator plate **1.** Also, referring now to **Fig. 2**, the intake and outlet regions **60, 62** of the entry and exit openings to the gas flow channels form the weakest point of the separator plate/transverse-flow plate joint. In those regions, the thin metal bi-catalyst separator plate is joined to a transverse-flow plate only on one side. One approach to insure proper adhesion when brazing is to use solid inserts that may be placed in the transverse flow plate entries **60** and exits **62** to press the separator plate against the transverse-flow plates. However, removing such inserts, after brazing the sub-assemblies and before assembling the cells into a finished stack, is difficult and leads to low sub-unit production yields.

[0035] Thus, according to another aspect of the present invention, a good seal is obtained while obviating both cleaning the oxidized separator plate and the use of brazing inserts. This aspect of the present invention is illustrated in **Fig. 2**, and is accomplished in a first method of assembly embodiment by brazing the transverse-flow plates **2, 3** to the separator plates **1, 1`** prior to coating with catalyst as shown by dashed arrows 100 and 101. Thus, only fresh, clean surfaces are brazed to form sub-assemblies consisting of a separator plate sandwiched between two transverse-flow plates, sub-assemblies **D** and **E** of **Fig. 2**. After the catalyst coating is deposited on the area of the separator plates that is exposed in the channel opening **40** of the sub-

assemblies, the sub-assemblies **D** and **E** (and others like them) are stacked to form the plate reactor structure. Any oxide layers formed on unintended surfaces of the sub-assemblies after depositing the catalyst coatings (e.g., the faces of the plates **2** and **3**) are easily removed without damage as the removal is from the exterior faces of the relatively thick transverse flow plate frames **2, 3**, rather than from the very thin separator plate **1**.

[0036] **Fig. 2** is an exploded isometric view of a sub-assembly suitable for joining by brazing. Fresh metal transverse-flow plates **4** and **6** are joined by brazing to a fresh thin metal separator plate **5** to form sub-assembly **D**. Similarly, fresh metal transverse-flow plates **6'** and **8** are joined to a fresh thin plate **7** to form sub-assembly **E**. Sub-assemblies **D** and **E** are treated to coat portions of the exposed surfaces of the thin plates **5** and **7** corresponding to the reaction zone areas **40** with reforming and combustion catalysts. Sub-assemblies **D** and **E** are thick enough that the exposed surfaces **70** of the transverse-flow plates can be cleaned without compromising the physical integrity of the subassemblies. Once the surfaces are clean, sub-assemblies **D** and **E** are joined by brazing to form a double unit **V**. Unit **V** is similar to unit **U** in **Fig. 1** except there are two transverse flow plates, **6** and **6'** joined together in the center of unit **V**. That is, the transverse flow plate can be constructed of two or more thinner platelets. As shown, the unit **V** has on both its top and bottom the **C** side of the separator plate exposed. Corresponding units can be constructed having both **R** side catalysts exposed, or the termination plate can be a separator plate so the unit has alternate catalyst ends, as needed. Multiple cells of the various types of sub-assembly **V** units can be assembled into a stack that contains a plurality of alternating combustion and reforming channel-type reaction zones. The stack includes end insulators and end plates, with appropriate through holes and fastening bolts (not shown as they are conventional).

[0037] **2. Gasket sealing.** According to a second construction and assembly aspect of the present invention, a safe seal can be provided between the separator